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With regards of  
R. H. Fitz.

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THE  
THEORY OF TUBERCULOSIS.

A BRIEF ACCOUNT  
OF  
SOME OF ITS MORE IMPORTANT FEATURES.

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BY R. H. FITZ, M.D.,  
OF BOSTON.

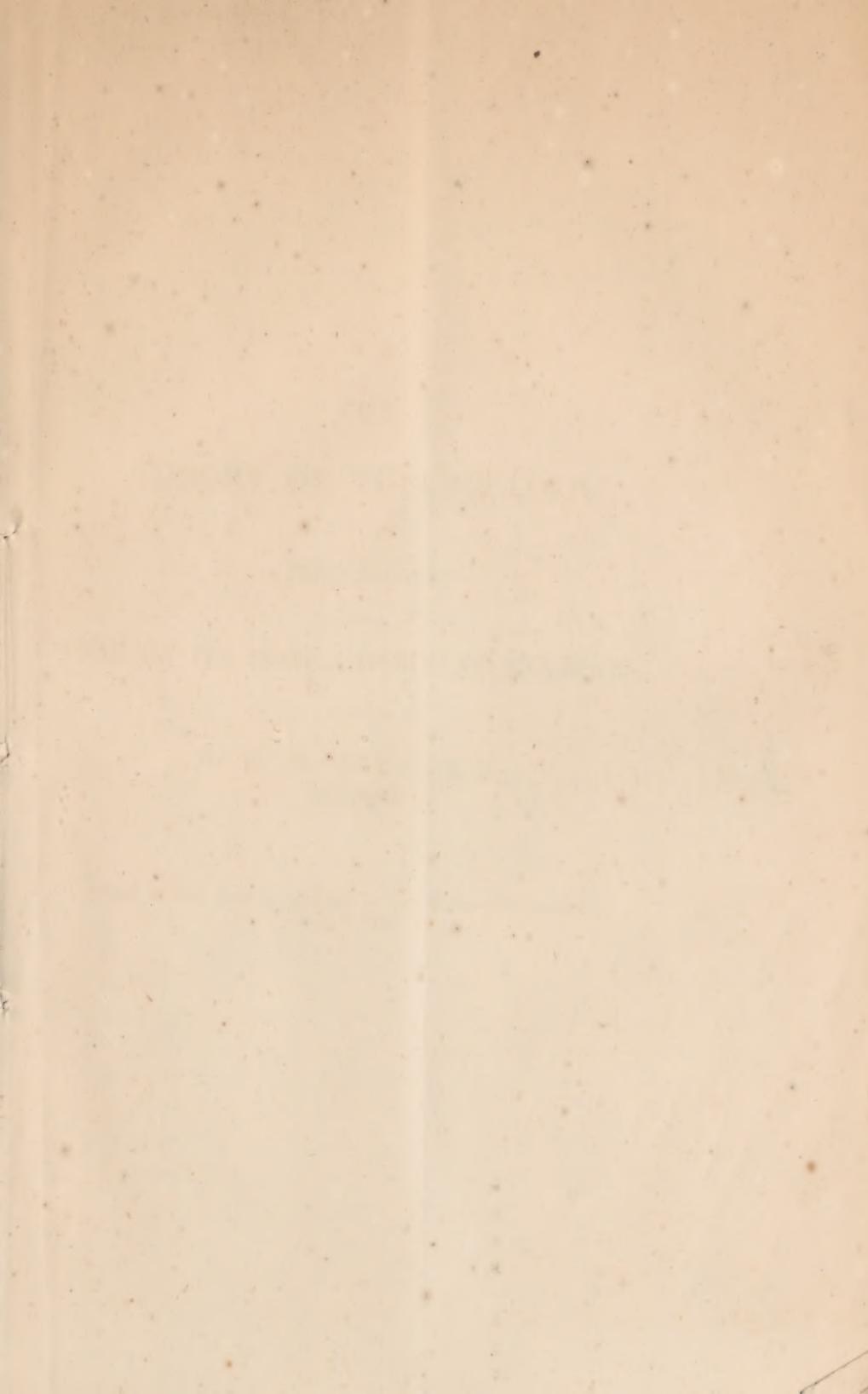
READ AT THE ANNUAL MEETING OF THE MASS. MED. SOCIETY,  
June 6, 1871.

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Presented by  
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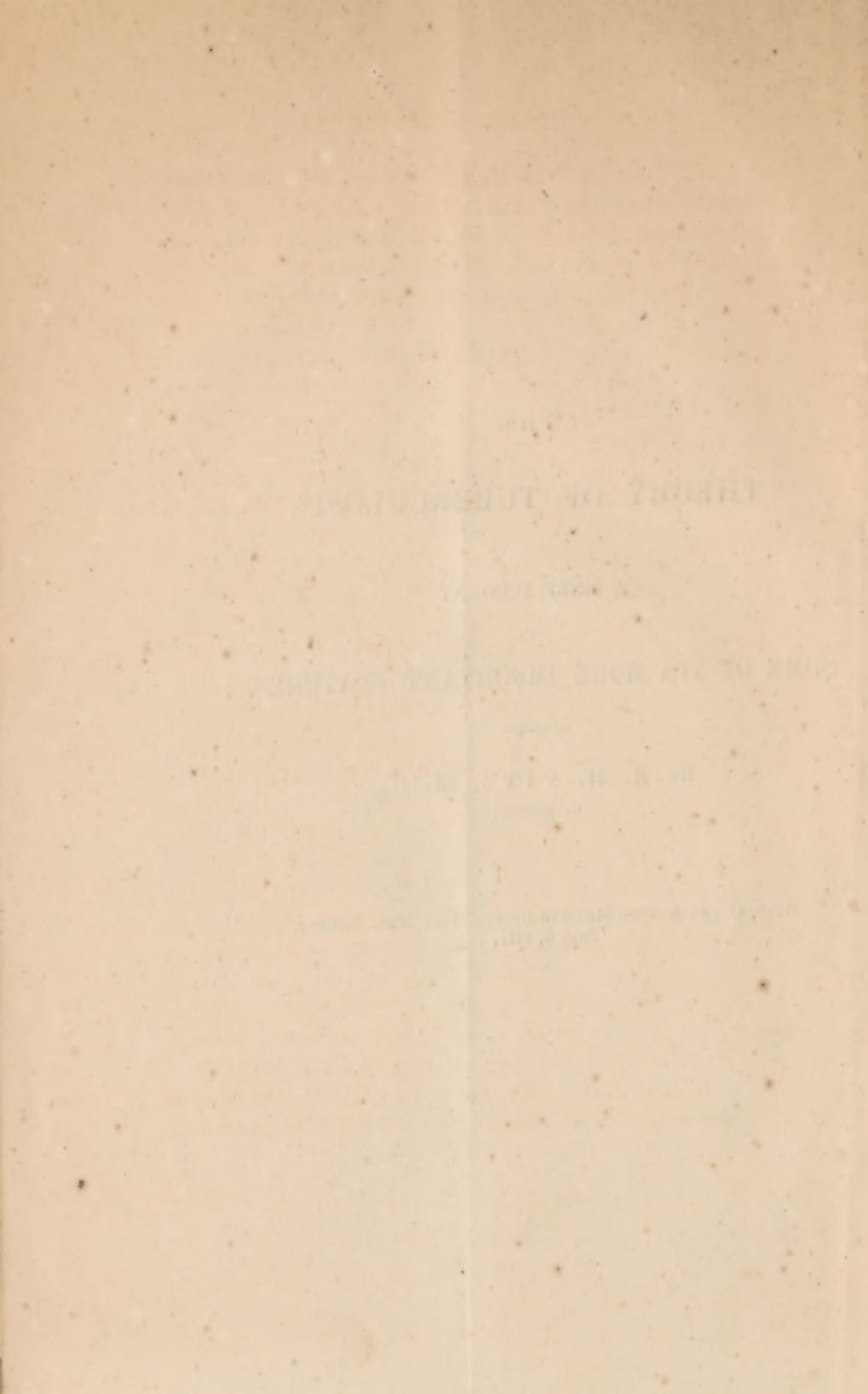
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By R. H. FITZ, M.D.  
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## THE THEORY OF TUBERCULOSIS.

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As is well known, the theory of tuberculosis at the present day differs widely from that found in the majority of text-books, and the results furnished by recent investigation and experiments have not as yet met with that general attention which they deserve. It is not my purpose to bring forward matter resulting from original research on my own part, but to lay before you facts derived from the investigations of others, together with some of the conclusions which have been drawn, especially with reference to the relation which phthisis bears to tuberculosis.

The term tubercle was originally adopted for the purpose of describing the shape and size without reference to origin or structure, hence was not suggestive of a specific condition. Tubercles were small, more or less spherical nodules, at first seen upon the surface of the body, then upon bones; later, as anatomy demanded an increased field for observation, little nodules were also found in the interior of the body. The specific tubercles were first spoken of towards the close of the last and at the commencement of the present century.

The term phthisis too, originally referred simply to the wasting occurring in certain forms of chronic disease; it was used merely in the clinical sense, without special reference to anatomical conditions. The most common form of phthisis being that arising from chronic disease of the lungs, its use

became more or less restricted to these organs. The term phthisis pulmonum, even in ancient times, by no means referred to a single form of disease. The history of this subject has been most carefully and thoroughly developed, in most cases from the original sources by Waldenburg,\* of Berlin.

Sylvius† described a condition of the lungs where ulcers and abscesses existed, either directly or from metamorphosed blood, and another in which larger and smaller tubercles were present, which might soften and thus give rise to cavities. He regarded these tubercles as glands which enlarged in the same manner as scrofulous glands elsewhere in the body. From this point of departure arose the confusion between phthisis and scrofula.

During the following hundred years, similar ideas prevailed. Mead‡ says, "And indeed in the dissection of bodies dead of consumption we very often find the lungs beset with tubercles or indurated glands which had suppurred and thrown off purulent matter." Cullen§ considered phthisis pulmonum to be "an expectoration of pus or purulent matter from the lungs, attended with a hectic fever." In all cases of the expectoration of pus he assumes that an ulceration of the lungs exists, which ulcer may arise from haemoptysis, from suppuration the result of pneumonia, from catarrh, asthma and tubercle; tubercle he considers as the most frequent cause. Tubercles with him mean "certain small tumors which have the appearance of indurated glands;" these, indolent at first, become inflamed and thereby changed

\* Waldenburg. *Die Tuberculose, die Lungen schwindsucht und Scrofulese.* Berlin, 1869.

† Waldenburg, op. cit., p. 27.

‡ Mead, *The Medical Works of, Edinburgh, 1775*, p. 358.

§ Cullen, *The Works of, Thomson, Edinburgh, 1827. Vol. II. Book 4, chap. 4.*

into little abscesses or vomicæ which break into the bronchi. He admits that it can hardly be supposed that all the tubercles are tumefied glands, and accounts for some through haemorrhage into the cellular texture of the lungs, the entrance of dust, which obstructs the bronchi, and either thus form cysts or produce congestion of the neighboring glands which have the appearance of tubercle.

A year after Cullen had thus declared his views (1784), Stark, an English physician, first described at length the small tubercles, and soon after, Reid\* separated tuberculosis from scrofula, and regarded the tubercle as something quite distinct from a gland and denied its origin from haemoptysis.

Baillie† accepts the new idea and denies the glandular structure of tubercles. "They are at first very small, being not larger than the heads of very small pins, and in this case are frequently accumulated in small clusters. The smaller tubercles of a cluster probably grow together and form one larger tubercle. \* \* \* \* \* When cut into, they are found to consist of a white, smooth substance, having great firmness and often containing in part a thick, curdly pus." Baillie considered tubercles as deposited scrophulous material.

In 1803, Vetter‡ distinguished a phthisis pulmonum resulting from vomicæ, the result of inflammation of the lung tissue, and a tabes pulmonum caused by tubercle. He agreed with Reid in that the tubercle had no necessary connection with scrofula nor with glands. He granted that the tuberculous material resembled that which one found in

\* Reid. *An Essay on the Nature and Cause of Phthisis Pulmonalis*, London, 1785, p. 37.

† Baillie. *The Morbid Anatomy of some of the most important parts of the Human Body*, London, 1793, p. 46.

‡ Waldenburg, op. cit., p. 57.

scrofulous glands, and called it cheese-like. He described tubercles of the peritoneum, intestine, liver, spleen and uterus, but did not connect them with tubercles of the lung; the latter were specific, and had nothing in common with the former.

The great work of establishing the theory of specific tubercle was now transferred to Paris, and Laennec's brilliant discovery enabled him to present his theoretical views in an exceedingly practical light.

The new movement was excited by Bayle,\* however. Finding similar appearances in other organs in cases of pulmonary consumption, he considered that such might result from a common cause. With him, tubercle became tuberculous matter, the tuberculous affection was probably of a scrofulous nature, and the scrofulous glands were those which were transformed, entire or in part, into tuberculous matter. Bayle† also described the miliary granulations; these were never opaque, nor did they soften, and were thus to be distinguished from miliary tubercles which they very much resembled in size, but which, on the contrary, were always gray or white and opaque. These miliary granulations also occurred in various organs and produced a specific general degeneration. The miliary granulations and the miliary tubercles generally occurred simultaneously, yet, on account of the differences previously mentioned, were considered as having a different origin, though each produced a special variety of phthisis.

Laennec‡ now (1819) published his work on auscultation, in which he brought forward his theory of tuberculosis,

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\* Bayle. *Recherches sur la Phthisie Pulmonaire*. Paris, 1810.

† Op. cit., p. 26.

‡ Laennec. *Traité de L'Auscultation Médiate et des Maladies des Poumons et du Cœur*. Tomes II., 2ème Edition. Paris, 1826.

the same which was accepted by the general medical world, the same which in the minds of some exists unaltered at the present time. The tubercular material\* could appear in the lungs and in other organs, as isolated bodies and as infiltrations; of the former were miliary tubercle, crude tubercle, tuberculous granulations and encysted tubercles. Tuberculous infiltrations occurred as gray and yellow shapeless masses.

The tuberculous material originally is gray and semi-transparent, later it becomes yellow, opaque and very dense. Then softening occurs, and one has a fluid resembling pus; this being expelled through the bronchi, there remains the tuberculous cavity. Phthisis is not the result of an inflammation of the lungs, a view already advanced by Bayle. Tubercles are not caused by haemoptysis, though the latter often occurs when the former are present. Laennec describes the various organs where tubercles are found; he states that they may also exist in certain tumors which one generally confounds under the term scirrhus or cancer; in such cases they may be either isolated or diffused. The development of tubercles is the result of a general disposition, and if inflammation occurs in connection it is generally secondary.

With Laennec, then, there was but one pulmonary phthisis, and this the result of the development of a specific growth, the tubercle. All nodules in the lungs, excepting those which were cancerous or cretified, whether varying in color, size or density, were tubercles. Nearly all masses filling up the air spaces, in long-standing disease, came under the same general law, and all cavities were the result of the same original cause, with the exception of those arising from gangrene of the lung.

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\* Op. cit., vol. i. p. 532.

Broussais,\* the most active opponent of Laennec, published the first edition of his work in 1808. Phthisis† with him was a chronic inflammation destroying the lungs, almost always produced by a degeneration of the lymphatic vessels. Pneumonia, catarrh and pleurisy could produce tubercular phthisis. In inflammation of the lymphatic glands‡ one has a gray, brawny swelling; instead of an exudation, one has a white, concrete, inodorous product, offering exactly the aspect and consistency of cheese. One has agreed to call this white matter tubercular.

The views both of Broussais and Laennec contained each the germs of truth, as we shall subsequently see; but in order to carry out individual theories, facts were made to correspond with theories, rather than the reverse, and as Laennec's ideas prevailed, the truths of Broussais remained dormant.

Of the two celebrated authors who followed Laennec, the one, Andral,§ differed somewhat in his views. Tubercle was considered as the result of a modification or perversion of secretion, often attended or preceded by an active or sanguineous congestion. This secretion was most usually seated in the cellular tissue, hence all tubercular matter is infiltrated.

The original form of the tubercle was not "a grayish, semi-transparent granule."|| In all the granulations tuberculous matter may be formed as pus may; the granulations are for the most part the effect of a partial pneumonia. From the views thus stated, it would seem that he followed

\* Broussais. *Histoire des Phlegmasies ou Inflammation chronique.* 2 Tomes. Paris, 1808.

† Op. cit., vol. i. p. 318.

‡ Op. cit., vol. i. p. 21.

§ Andral. *A Treatise on Path. Anatomy,* translated by Townsend and West. 2 Vols. Dublin, 1831.

|| Op. cit., vol. i. p. 509.

Broussais in considering the tubercles as the result of inflammation, but differed from him in not confining the same to the lymphatic system. From Laennec he differed in denying the specific character of the tubercle, and in considering the miliary granulations as having nothing in common with tubercle. Andral made a very valuable contribution to the subject by calling attention to the condition of the lymphatics leading from intestinal ulcers, which he found to be laden with pus in a fluid or semi-solid condition, bearing, as he says, a strong resemblance to the matter of tubercle. He also speaks of the presence of an apparently tuberculous matter in the interior of cavities lined by a mucous membrane, where ulceration has not existed, and states that mucous follicles are sometimes filled with a substance which has exactly the aspect of tuberculous matter.

The other author, whose influence was exerted in favor of Laennec, was Louis.\* The tubercle was specific, the primary stage was that of the granulation, through which the tubercle must pass before assuming its peculiar character, i. e. becoming dull, yellowish-white, of friable consistency. At the same time he suggested that in certain cases of acute phthisis the tuberculous matter might be deposited in its mature, characteristic state, from the fact that sufficient time had hardly intervened for the transformation of an originally gray matter.

In Germany, but little original thought on the subject of phthisis had arisen, till these ideas of Laennec and Broussais were promulgated.

Schönlein† makes a distinction between serofula and tu-

\* Louis. Pathological Researches on Phthisis. Cowan's Translation. London, 1835.

† Schönlein. Allgem. und Specielle Pathologie und Therapie. 4 Theilen, 3te Auflage. St. Gallen, 1841.

berele. In the former,\* a peculiar diseased product arises, of the density of Swiss cheese, a brittle, yellowish-white mass; this is the serofula-matter, which may be deposited in various organs. The tubercle is distinguished from the same as being a true new-formation, round. He states that tubercle† is allied to serofula, though not identical; commencing as a vesicle filled with gelatinous fluid, the agglomeration of such and the individual increase in size produce varieties of form. Pulmonary phthisis not rarely occurs from other causes than tubercles. In phthisis‡ a morbid surface forms in the diseased organ, from which a peculiar stuff is secreted, which one generally calls pus; as this secretion becomes more copious, one has consumption. A similar formation in other organs than the lungs produces phthisis also; e. g. phthisis hepatica, a term applied to abscess of the liver.

Rokitansky§ considered tubercle as an exudation of solidified protein substances (fibrine, albumen), distinguished by the tubercular form, either as scattered or collected nodules, or by its deposition in granulations and stellate masses. This view resembles very much that of Andral, his secretion being Rokitansky's exudation; the latter, however, made a decided advance, in re-directing attention to the descriptive element of the term. He admitted the gray, semi-transparent tubercle, but also a "fibrino-croupous" form which was opaque from the first. These two forms were distinguished from one another also by final results, the former shrivelling into a tough, amorphous or distinctly fibrous

\* Op. cit., 3te Theil. p. 44.

† Page 69.

‡ Page 89.

§ Rokitansky. A Manual of Path. Anatomy, 4 vols. Sydenham Edition, 1852. Vol. i. p. 293.

mass, the latter softening and producing ulceration. Tubercle was the product of inflammation; a portion of the resulting exudation, however, might become absorbed or organized, or the entire exudation becomes tuberculous. Tubercle and serofula are identical; tuberculosis and serofulosis one and the same disease. He also maintained the existence of another variety of tubercle, the albuminous, occurring in acute tuberculosis. This form is only rarely the primitive one, and is subject to no metamorphosis.

Vogel's\* researches threw additional light upon the subject. He states that in serofulosis as in typhus, depositions occur in various parts of the body, most commonly in the lymphatic glands and their vicinity, but also in other glands and in other organs; the only essential difference is, that the whole proceeding is accomplished much more slowly, the deposit and softening generally lasting as many weeks or even months, as in the other case days. Serofulous matter cannot with certainty be distinguished from typhoid or tuberculous matter. Tubercle is a pathological new-formation, produced in consequence of a specific disease, or morbid tendency, tuberculosis. Tubercular matter cannot be distinguished with certainty from the serofulous, typhous, or from that derived from any other ulcerative process. The formative substance of tubercle is originally fluid, secreted from the capillary vessels, the results of the blastema theory, the view entertained by Schölein. Truthfully enough he states that this fluid condition cannot be directly observed, for one first sees the tubercles as solid bodies. Gray and yellow tubercle can both exist primarily. In the former, we have an amorphous mass and cellular structures, in the latter the granular elements prevail.

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\* Vogel. *The Path. Anatomy of the Human Body*, translated by Day. London, 1847.

Lebert\* regarded as peculiar to tubercle, certain bodies whose characteristics are very completely described in the article referred to. By means of the microscope he asserted that he could distinguish the tubercle from pus or cancer, and by the microscope alone can one distinguish between concrete pus and tubercle. These corpuscles were seen best in the yellow tubercle, though they also exist in the gray form. There is no peculiar scrofula material: what one regards as such, is generally the result of an ordinary inflammation or suppuration under the influence of a dyscrasial element. These views with regard to the structure of tubercle were generally received till 1847, when Reinhardt and Virchow† published the results of their investigations, the one with regard to the granular corpuscles, the other with regard to the development of cancer. It was there shown that these tubercle-corpuscles were shrivelled cells and nuclei in a stage of retrograde metamorphosis, and were to all intents and purposes dead. The metamorphosis was shown in physiological and pathological conditions of the most varied nature. Virchow called attention to the fact that the masses thus formed in cancer bore the greatest resemblance to crude tubercles, the same with regard to inspissated pus. Some years later one of our own number, Dr. C. Ellis,‡ from a series of special investigations, extending over a number of years, came quite independently to a similar conclusion, that the yellow tubercle was simply the result of degeneration.

In 1850, Reinhardt§ asserted that the changes taking place in tubercular processes agreed with those occurring in chronic inflammation; "every deposition of tubercle is

\* Lebert. Moller's Archiv für Anatomie und Physiologie, 1844, p. 194.

† Reinhardt. Virchow. Archiv für Path. Anatomie, 1847. Vol. I. pp. 20, 94.

‡ Ellis. American Journal of the Med. Sciences, 1860.

§ Reinhardt. Annalen des Charité-Krankenhauses. Berlin, 1850.

only a more or less extensive chronic pneumonia, and the only peculiarity of pulmonary tuberculosis is, that these chronic inflammations repeat themselves at longer or shorter intervals."\*\* Reinhardt therefore agreed more particularly with Broussais and Andral, and denied *in toto* the views of Laennec with regard to the specific character of tubercle.

Virchow, starting with the same amount of positive knowledge of the condition of so-called yellow tubercle, came to different results. The error of Reinhardt was the same as that of the observers preceding him. A given series of facts being obtained, all conditions were regarded as holding a necessary connection with the single premises. Virchow saw that the yellow, opaque material resulted from various conditions in different organs, and under circumstances which had no connection with phthisis or tuberculosis, as well as the reverse, and instead of seeking at the outset for a common pathological cause, inflammation for instance, the history of each individual process resulting in the formation of the so-called tuberculous or serofulvous material was sought for, and the result was arrived at that there were inflammatory conditions producing the result, and that there was a specific tuberculosis in which, at a certain period, similar appearances presented themselves.

In 1850,† speaking of tuberculous inflammation, he calls attention to the fact that in the inflammation of serous membranes the fibrinous exudation becomes organized, at the same time tubercles may form. He opposes the idea of Rokitansky that a mixed exudation of inflammatory and tuberculous constituents existed; on the contrary a vascular cellular tissue formed in one part, while in another the formation of cells increased by endogenous growth so rapidly

\* L. c., p. 376.

† Virchow. Wurzburger Verhandlungen, 1850. Vol. i. p. 83.

that their number became very great at certain points. The retrograde change then commenced ; after partial fatty metamorphosis, the cells became destroyed and a granular detritus remained in which the cell-nuclei could be recognized for some time. The tubercle here arises from a metamorphosis of organized elements, not from an exudation. The so-called tubercle corpuscles are the altered nuclei. He then calls attention to the fact that the tuberculoid (*tuberkelartige*) metamorphosis consists in an atrophy of the tissue elements, accompanied with inspissation. The commencement of the process is the origin, accumulation and endogenous increase of the nucleoid and cell-like formations. He acknowledges that it is impossible to state whether this process is inflammatory or not. "We know that inflammatory new-formations may become tubercular, and that the tuberculoid metamorphosis is not the peculiarity of a specific process, of a special constitution." The distinction here drawn between the tubercular process and the tuberculoid metamorphosis is the starting point, the one which is the groundwork of the present theory, the one which is totally at variance with that of Laennec, for with him tubercular and tuberculoid were synonymous, the latter being merely a stage of the former.

Virchow also, in the article referred to, contends against the dyscrasial nature of tuberculosis, as one has not been able to find any special alteration of the blood.

The tuberculosis is a local process, in many cases produced by merely local conditions ; that the process may afterwards become "constitutional" is not denied. He also calls attention to the fact that certain organs are predisposed to tuberculosis. At this time it seems as if a distinction were made by him between tuberculous inflammation and specific tuberculosis, though the development is asserted as

analogous. In speaking of specific tuberculosis the lungs are referred to as the example, and the development of tubercle is to be seen to the best advantage in the epithelium of the pulmonary alveoli. First the endogenous formation of cells, then the metamorphosis either fatty or tuberculoid. Then again,\* with regard to the formation of cavities in the lungs, he states that such are simple bronchial dilatations, ulcerative cavities, the result of tubercle, abscess, gangrene, or mixed forms of dilatation and ulceration. The pulmonary tubercle then, so far as one can judge, is not only a mass of tuberculoid metamorphosis, but also the single specific tubercle of Laennec arising from changes in the pulmonary epithelium.

In 1851† he expresses his views with more precision :

"1. Tuberculosis, the undoubted local process through which the body called tubercle is formed, does not consist in a peculiar specific exudation, but in a peculiar conversion of tissue elements, which in 1847, as occurring in cancer, I described under the name of tuberculoid metamorphosis.

\* \* \* . . \* \* \* \*

"8. Tuberculosis is the entire process of the disease which comprises the conditions of local nutritive disturbances with the accompanying changes of exudation, cell-formation, and metamorphosis, and which finds its regular expression in tuberculization. Every tuberculization (tuberculoid metamorphosis) does not proceed from tuberculosis. Tuberculosis may be present in its earlier stages (exudation, cell-formation) even when no tubercle is present. We call tuberculosis the diseased process which in its usual course always leads to tuberculization, while we refer to an entirely different process, cancer and sarcoma, which accidentally be

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\* Würzburger Verhandlungen, vol. 2, p. 27.

† Würzburger Verhandlungen, vol. 2, p. 72.

tuberculoid, and the term tubercle should never be applied to a condensed abscess, cheesy pus (*pus concret*).

\* \* \* \* \*

" 10. The tubercle, in so far as it arises from the accumulation of cells in tissues of the most varied sort, which cells in the majority of cases fall to pieces, is destitute of every complete, really characteristic element. Of the remains of the cells the shrivelled nucleus presents the most constancy in its external appearance, and therefore we may retain for this the name of tubercle corpuscle."

From this statement one would infer that the tubercle first existed after tuberculization (the tuberculoid metamorphosis) had commenced, though in tuberculosis a stage existed where no tubercle was present. That confusion should arise from such a collection of terms was a necessary result, and Lebert suggested the name "phymatoid" for the tuberculoid condition.

In 1852,\* the statement of the distinctions between phthisis and tuberculosis pulmonum is made, and at the same time the terms are so altered that misunderstanding is prevented. The general medical world received for the first time a systematic collective representative of Virchow's views upon the subject. The term "cheesy metamorphosis" is substituted for the tuberculoid; the tubercle is a peculiar, nodular, organized formation which under certain conditions may become cheesy. After calling attention to the fact that since the time of Laennec one has identified pulmonary phthisis with tuberculosis, he states that his own views with regard to pulmonary phthisis are more allied to those of Bayle and even Morton. He finds various sorts of phthisis which depend upon pulmonary affections. The cheesy infil-

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\* Würzburger Verhandlungen, vol. iii. p. 98.

tration of the pulmonary parenchyma is not a necessary condition of phthisis, whether it is in connection with real tubercle or with a condensation of accumulated bronchial secretion. Ulcerative bronchitis, chronic, broncho-blennorrhea, with cheesy infiltration of the bronchial glands, purulent chronic pneumonic infiltrations, all produce phthisis. The cheesy masses which Carswell and Reinhardt found in the bronchi and alveoli of the lungs, and whose development was traced from thickened pus, are not tuberculous, for at times near them or independent of them one sees the same nodular disease which is so pronounced in tubercular meningitis. Acute and chronic tuberculosis are developed from gray, cellular, at first soft, later firm accumulations, in which the brittleness of the cells and the abundance of the nuclei are striking. There is a tubercular bronchitis in which the membrane secretes pus and contains in its interior tubercles, just as in a tubercular meningitis one has tubercular granulations and fibro-purulent infiltration. He considers it advantageous to separate altogether the idea of pulmonary tuberculosis from pulmonary phthisis.

Virchow's views thus set forth were productive of immense results. Other workers entered the field, and the various questions which arose as to the origin, contagiousness, inoculation and treatment are still in the process of solution. What tubercle is, seems definitely settled through Virchow's means; how and why it occurs are debatable questions, the weight of evidence tending now in this direction, now in that. The diagnosis of tubercle in special instances is a matter of some considerable uncertainty. Indeed it is by no means improbable that certain appearances which one now calls tubercle, at some future day may be regarded as having only an accidental connection; the general tuberculosis which so often coëxists may be simply consequent with-

out being specifically so, though a causal relation may very likely exist.

Since 1852, with the increased field for observation and the valuable assistance to be derived from experiment, with improvements in method and instruments, the views of Virchow have become elaborated and generalized, till the theory of tuberculosis has become a statement of facts explained in a manner which leaves but little room for doubt. Virchow's views are to be found most fully stated in his work on Tumors,\* a work unfortunately not yet complete.

What then shall one consider as tubercle, and how is the same to be distinguished from other appearances which have hitherto been regarded as such? According to Virchow, the tubercle is an organized new-formation in that it has a cellular composition, though non-vascular. He classes it among the tumors, considering it as a sort of lymphatic tumor from the structural resemblance to that of the lymphatic glands. It is a small, spherical body, about the size of a Malpighian corpuscle of the spleen, often, indeed, somewhat smaller as in the acute tubercle of the liver, and rarely larger than a mustard seed. At first gray and somewhat glistening, as it becomes older the fatty degeneration going on in its cellular elements gives rise to a white, opaque appearance, with less lustre, and finally the nodule becomes yellow.

As before stated, it is made up from the beginning of cells; these are spherical, in general smaller than the white corpuscles of the blood, and contain one or more nuclei. Large cells exist, however, though to a slight extent, and contain several nuclei, at times as many as twelve. These cells are closely packed together in a delicate meshwork of slender fibrils. Should bloodvessels be found in the interior

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\* Virchow. *Krankhaften Geschwülste.* 3 vols. Berlin, 1863. Vol. ii. p. 620.

of the tubercle, they are, as a rule, such as previously existed in the part before the tubercle made its appearance. The cells have only a brief period of existence, and rapidly undergo fatty degeneration ; hence it is rare to find the tubercle, at least in most organs, where this change has not already commenced. The degeneration begins in the centre, the part farthest removed from nutrition, and is often recognized as an extremely minute white spot in the midst of the otherwise gray, somewhat transparent nodule. At the same time there is more or less peripheral absorption, producing a certain degree of inspissation of the new-growth, and one has the cheesy tubercle. Later, softening, liquefaction occurs, at first in the centre, and on section the minute cavity is seen filled with a yellowish-white and opaque fluid of the consistency of cream. Virchow calls attention to the more fibrous tubercle which develops in firm, fibrous parts, not unfrequently where newly-formed fibrous tissue exists. Such are denser, more transparent and pearly, and are usually found in connection with the more common form.

Tubercular nodules are often found as large as walnuts ; these, however, are never single tubercles, but are made up of hundreds, thousands, even, of the minute, individual tubercles. The growth of these larger nodules takes place from the periphery, and one sees upon the border, in the injected tissue, the small gray tubercles immediately surrounding the large nodule. The agglomeration of such produces the central mass, which latter has already undergone the cheesy degeneration. Not rarely one finds about the central mass a more or less firm capsule of connective tissue in which the growth advances. These tubercular nodules are best seen in the brain and spinal cord. The supra-renal capsule, too, is a frequent seat. When such a change takes place in the kidneys, the tubercles are packed closely to-

gether, imbedded in the structure of the kidney, the epithelium of which undergoes a similar metamorphosis to that of the tubercle cells : and these changes commencing generally in the medullary region, as softening occurs portions are discharged, one has a large, irregular cavity with cheesy walls, communicating freely with the pelvis of the kidney, a condition which has been called renal phthisis. The agglomeration of the single tubercles takes place also on serous membranes, as the pleura and peritoneum ; in such cases the form is rather that of flattened, somewhat elevated patches. When the tubercles occur in mucous membranes they are, as always, at first isolated ; as the cheesy metamorphosis advances, one has a death of that portion of the membrane containing the tubercle, and this dead portion is thrown off, a minute, relatively superficial ulcer resulting.

In tuberculosis of these membranes, numerous tubercles exist however, numerous ulcers follow, these ulcers run together, and the border becomes serpentine and crenate, owing to the confluence of the various ulcers.

Such changes are best seen upon the mucous membrane of the pelvis of the kidney, the uterus and bladder. Then, too, one often finds secondary tubercles imbedded in the base of the ulcer and in its periphery, so that the ulcerated surface increases in depth and width by the softening and discharge of these, seen to best advantage in tubercular ulcers of the intestine. Virchow speaks of the minute, shallow ulcer of the larynx, where the original tubercles, lying quite superficially, disappear by a loss of substance from the surface, without becoming cheesy.

Then again, in the smaller bronchi, the vasa deferentia and vesiculae seminales, where a free outlet to the secretion does not readily take place, one has in addition to the cheesy tubercle imbedded in the thickened, white and opaque mu-

eous membrane, a mass of secretion constantly increasing, and undergoing the cheesy metamorphosis; so that finally the tube becomes distended with the mass of softened tubercles and catarrhal secretion from which the fluid portions have become more or less completely absorbed, and on section one sees the firm, yellowish-white, homogeneous mass, presenting the general resemblance to Swiss cheese. Such, then, are the appearances assumed by the tubercles from their perceptible origin till their disappearance through softening or ulceration, or both.

All tubercles are at the outset miliary, that is, minute, and where an appearance of so-called infiltrated tubercle exists it is almost invariably due to other causes, with perhaps but one exception.

In speaking of the conglomerated tuberculous nodule of the brain, Virchow states that a period of rest in the growth of the same may occur. Hence one does not find upon the border, at this stage, the minute tubercular granules, but, on the contrary, one has a continuous, hard, cheesy substance.

As one can readily see, the admission of such an occurrence renders extremely difficult in many cases the diagnosis of such a cheesy mass. There are cheesy alterations occurring in syphilitic tumors of the brain, so that from the appearance alone of the new-growth a differential diagnosis is impossible. Virchow states, indeed, that there are cases where one is even inclined to admit a third form of cheesy cerebral tumor. As a rule, however, the clinical history of the case, and the appearances found in other organs, will enable one to form a relatively accurate opinion.

Where, then, does the tubercle exist? According to Virchow, in the connective tissue or in allied tissues, as the medullary, fatty, and osseous, and arises from a proliferation of the pre-existing tissue, not from an exudation. The con-

nective tissue, however, may have arisen from an exudation, as in tubercle of pleuritic adhesions. In the brain one finds the minute tubercles in the external sheath of the smaller arteries of the pia mater. Virchow speaks of an appearance often seen in connection with the dense fibrous form of tubercle, where the suspicion arises that in them lymph vessels with a proliferation of the epithelium from the wall occurs. Rindfleisch\* describes the development of tubercles of the omentum from the epithelium covering this; a method of origin at present somewhat problematical. The tubercle never exists primarily upon the free surface, but is always developed in the interstitial tissue of the organ; whether or not the development bears a definite relation to the vessels of the part, or to the lymph spaces, following a general law of development, is a matter as yet remaining undecided.

One finds in the cerebro-spinal axis the tubercles developing rapidly, within the course of two or three weeks, and terminating fatally in the form of a cerebro-spinal meningitis; or one finds the growth localized, generally in the gray matter of the brain, extending over a period of months, perhaps years, in the form of the solitary nodules made up of thousands of original tubercles.

This same distinction exists elsewhere in the body, most marked and most frequently seen in the kidneys, supra-renal capsules and testes. Whether a similar chronic tuberculosis of the lungs exists is a matter not to be asserted definitely. One often finds in these organs evidences of acute miliary tuberculosis combined with chronic cheesy conditions of inflammatory origin; in such cases, however, the former are secondary to the latter. And in fact it can be maintained

\* Rindfleisch. Lehrbuch der Pathologischen Gewebelehre. Leipzig, 1867-9.  
P. 222.

that acute miliary tuberculosis is generally secondary to pre-existing disease of a chronic character, which at the same time may present itself in the form of the agglomerated tuberculous nodules and patches previously spoken of.

Tuberculosis of the lungs presenting perhaps the chief interest to the members of the Society, I will endeavor to bring together the main facts in the distinction between the cheesy conditions which form the most common cause of phthisis, and the tubercles of the lungs. As has been previously shown, the catarrhal secretion which is retained in mucous passages, especially the narrow ones, being made up in the main of cells, becomes cheesy through partial fatty metamorphosis of the cells and absorption of the liquid portions. With this fact well borne in mind, the explanation of so-called infiltrated tubercle of the lungs becomes easy. On opening the bronchi to their finer ramifications in these cases, the thickened, curd-like material is found lying in the lumen of the bronchus; the lining membrane being swollen, thickened and rendered white by chronic inflammation, we have a clue to the origin of the round nodules with thickened capsule and softened contents, which are merely cross sections of the smaller bronchi. If the portion of the lung containing these masses is squeezed firmly between the fingers, the little plugs of altered secretion can be pressed out from the tubes, and present a similar appearance to the sebaceous secretion in comedones of the face.

As one recalls the structure of the lung, it will be remembered that the pulmonary alveoli sit upon the terminal bronchi, and that the lumina of the two are continuous; the secretion being retained in the bronchi, it follows that the secretion is also retained in the alveolar recesses and undergoes a similar change. Hence the minute cheesy granules which are found in these cases. A chronic pneumonia is simply

one where this excessive secretion from the alveolar walls is retained and becomes cheesy. Neighboring portions of pulmonary tissue are in an oedematous condition, which oedema combined with a certain amount of cells in the alveolar spaces produces the so-called "gelatinous infiltration," and often one sees minute yellow specks in the midst of this gelatinous surface, which specks are nothing else than fatty-degenerated cells.

A thickening and condensation of the fibrous tissue about the bronchus produces a dense, firm mass which on length section manifests itself as gray, somewhat opaque lines; on cross-section one has a round border with a central cavity, the lumen of the bronchus. Does this development of fibrous tissue occur also in the intervals between the pulmonary lobules and about the vessels, one has a mass of cicatricial tissue which contracts, is firm, more or less colored with pulmonary pigment, and the appearance of so-called cirrhosis of the lungs is seen. If the chronic catarrhal condition with retention of secretion affects certain bronchi with their terminal ramifications at various parts of the lung, one has a relatively circumscribed broncho-pneumonia, which is an inflammation of the lungs proceeding from the bronchus. To such circumscribed forms of disease are due in great measure the so-called tubercles whether crude or healed, so often found at the apices of the lungs. A circumscribed inflammation of the pleura is set up, outside of these, hence the adhesions. As the nodule softens, becomes partially absorbed or cretified, depressions are produced by the contraction of the encapsulating cicatricial tissue, and the so-called tubercle is healed. In those cases where lobes of the lungs are converted into this homogeneous, dense, yellow mass, the cheesy pneumonia is of a lobar form; it may also be lobular if less territory is invaded. The true tubercle of the lung,

however, is always miliary, it never exists on the free respiratory surface, but always is imbedded in the tissue, whether in the bronchial mucous membrane, the interstitial fibrous septa, the sheaths of the vessels and bronchi, in the pleura, or in the adhesions between the pleural surfaces. If appearances supposed to be tubercles are found in the lung and not in the parts referred to, the probability, almost certainty, exists that such are due to modifications of the forms of chronic inflammation previously referred to, a probability rendered still more certain by the non-existence of tubercles in other organs of the body.

Niemeyer\* asserts "that every form of pneumonia under certain conditions ends in cheesy infiltration, and in no form of pneumonia is the cheesy infiltration the constant and sole termination."

With regard to the first clause considerable doubt may be expressed whether the fibrinous form of pneumonia, the croupous of Rokitansky, ever terminates in this way.

The catarrhal cheesy pneumonia occurs especially in those persons called serofulous, and in connection the bronchial glands become enlarged by the accumulation of lymphatic cells; these, too, become cheesy.

Though actual proof is wanting, it seems much more probable from the results of post-mortem examinations, that the fibrinous pneumonia terminates in resolution or death, and that the bronchial glands, swollen at first, undergo resolution in their turn if the case terminates favorably, the increased amount of cells disappearing.

Niemeyer states that in many cases the clinical history seems to prove his point, and that at times one sees a gradual transition from red and gray hepatization to cheesy infil-

\* Niemeyer. *Klinische Vorträge über die Lungenschwindsucht*, von Dr. Ott. 2te Auflage. Berlin, 1867. P. 10.

tration. Does this change occur as a stage of one and the same process it must be exceedingly rare, and the objection always remains, did not the cheesy condition precede the attack of acute pneumonia.

Niemeyer also maintained that haemoptysis\* was in certain cases the immediate cause of phthisis, a view directly opposed to that of Laennec and Louis, who considered the same as a symptom of the disease already existing in the lungs.

The haemoptysis produced the phthisis, in that the blood remaining in the bronchi and alveoli gave rise to a pneumonia the products of which became cheesy. This view was not a new one, but had already existed before the time of Laennec. This theory was supported in the main by clinical evidence. The results of experiments upon dogs and rabbits, however, furnish testimony opposed to this statement.

Perl and Lipmann† found that in bronchial hemorrhage, artificially produced in the animals above mentioned, the blood did not enter the finest bronchi and alveoli, and that in the larger bronchi no coagula could be found after twelve hours. They also assert that the blood flowing into otherwise healthy air-passages does not act as a cause of inflammation, but is in part expectorated, in part gradually absorbed, the only alteration of the parenchyma of the lung being a moderate emphysema of the parts affected and the immediate vicinity.

Difficulties of diagnosis exist elsewhere, as in the testis, bones, &c., but a consideration of these points would demand more time and space than I am allowed. Then as to the intestines, we recognize a serulous ulcer arising from enlarged follicles and groups of follicles (Peyer's patches),

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\* L. c., p. 48.

† Perl and Lipmann. *Virchow's Archiv*, vol. 51, 1870, p. 552.

and a tubercular ulcer arising from the presence of miliary tubercles. The two forms may be combined; an originally serofulous ulcer may become tuberculous. In judging of these ulcerations, should we not find in the base and edges nor on the peritoneal surface the minute tubercles, the ulcer cannot be regarded as tuberculous. The presence of cheesy material does not suffice for the diagnosis of tubercle.

Tubercle occurs in nearly all the organs of the body either as acute or chronic; the former is more or less general, the latter, usually local at the outset, gives rise to a secondary infection of the vicinity or to a general infection of the various organs. The acute general form runs its course rapidly, as a rule proving fatal within three or four weeks, the symptoms resembling those of typhoid fever; the chronic form, so long as it remains localized, may exist for months and even years. Virchow has never seen tubercles in the salivary glands, pancreas and breast. The ovaries are rarely affected.

Primary tuberculosis of the muscular system, according to the same author, does not occur; a secondary form, however, is seen when the process advances from neighboring organs. Not unfrequently one finds miliary tubercles in the heart-substance, and Virchow has also seen here a large cheesy nodule which he considered to be of tuberculous origin. In 1867 Cohnheim\* drew attention to the existence of tubercle in the choroid coat of the eye; at this time only four such cases had been recorded.

The clinical value of this discovery was placed in a strong light, and since then diagnoses of acute miliary tuberculosis have been made during life, by means of the ophthalmoscope.

Professor Buhl† of Munich, published the results of post-

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\* Cohnheim. *Virchow's Archiv*, vol. xxxix. p. 49.

† Buhl. *Zeitschrift für Rationelle Medicin*, 1857. Vol. viii. p. 50.

mortem investigations in 280 cases of tuberculosis and phthisis. In the vast majority of his cases of acute miliary tuberculosis, twenty-three in number, he found simultaneously **cheesy nodules and cavities in the lungs.**

He hence inferred that the acute miliary tuberculosis was an infectious disease produced by the entrance of the specific tubercular virus into the blood. Niemeyer\* modified this view by stating that the tuberculosis in most cases was a secondary affection, produced in some unknown manner through the influence of cheesy diseased products upon the organism. Hence the presence of cheesy material of any sort might give rise to the development of tubercle.

Virchow opposed Bühl's theory from the fact that many cases occurred where cheesy material was present, scrofulous lymphatic glands for instance, and not only was there no resulting tuberculosis, but the same was absorbed and permanent recovery resulted. Then, again, there were cases where tubercles occurred in the absence of cheesy conditions, though at the same time he admits that such are extremely exceptional.

Within the past few years experiments have shown that Bühl's theory contains the germ of truth. It has been demonstrated again and again, that bodies having the appearance and structure of miliary tubercle may be produced in the various organs of the body. Villemin,† in December, 1865, published the results of his experiments, from which he deduced that the cause of tubercle is inoculable and can be communicated from man to rabbits. This fact, previously discovered by Klencke‡ in 1843, had been forgotten, and Villemin's results were such, that numerous similar experiments were made in various parts of Europe.

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\* L. c., p. 26.

† Bulletin de l'Académie de Médecine. Waldenburg, op. cit., p. 210.

‡ Waldenburg, op. cit., p. 198.

The inoculation was brought about in numerous ways; by direct injection into the bloodvessels, the peritoneal cavity, into the trachea, subcutaneously, &c. &c. Substances of the most varied nature were employed, not merely particles of the fresh, miliary tubercle, but also from cheesy tubercles, from cheesy pneumonia, pus fresh and crude, phthisical sputa, blood from phthisical patients, bits of malignant tumors, mercury, coal-dust, fat, &c. &c. Positive results being produced by the inoculation of dead and living, animal and vegetable growths, the doctrine of the specific tubercular virus as proposed by Buhl fell to the ground, and was replaced by the theory of Hoffman and Niemeyer; for it was found that in the majority of cases the direct result of the inoculation was the production of cheesy material in the part subjected to the experiment, then occurred secondarily the development of tubercle.

The results of experimentation are most carefully formulated by Cohnheim and Fränkel.\* According to them, tubercle can be produced in guinea-pigs by the inoculation of gray, miliary granulations and from cheesy nodules. After it was ascertained that cheesy material produced this effect, charpie, gutta-percha and India-rubber were placed by them in the abdominal cavity.

Of the animals thus experimented upon, some died from general peritonitis, in others the inflammatory product became encapsuled, condensed. The inner surface of the capsule was in nearly all the cases studded with numerous small, gray, tuberculous nodules.

The general inference was, that "the dead and condensed pus received into the circulation served as origin for the tubercle."

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\* Cohnheim und Fränkel. *Virchow's Archiv*, 1868, vol. xlv. p. 216.

Waldenburg\* considers miliary tubercle to result from the absorption of finely divided corpuscular elements into the circulation, and their deposition, with the formation of nodules, at numerous scattered points of the various organs. Klebs† asserts that the tubercle virus is soluble in water, is precipitated on the addition of alcohol. On evaporating the aqueous solution the virus loses its efficacy. At the same time he finds it impossible to isolate completely the virus.

Clinical experience, then, as well as experiments upon the lower animals, show that in the vast majority of cases a connection exists between cheesy deposits and the presence of miliary tuberculosis. These cheesy deposits being in many cases the results of simple inflammation, a specific tubercular virus is not necessary for the production of tubercle.

Whether the irritation producing the growth of tubercle in any given part is brought about by the corpuscular elements introduced, or by the fluid surrounding and in them, the water of crystallization as it were, or whether an altogether new production arises from chemical changes in them, both elements and fluids, is unknown. The process of experimentation still goes on, the tendency is isolation, and science seems to have forced its way into the fissure at the bottom of which lies the immediate cause.

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\* Op. cit., p. 155.

† Klebs. *Virchow's Archiv*, 1870, vol. xlix. p. 291.



